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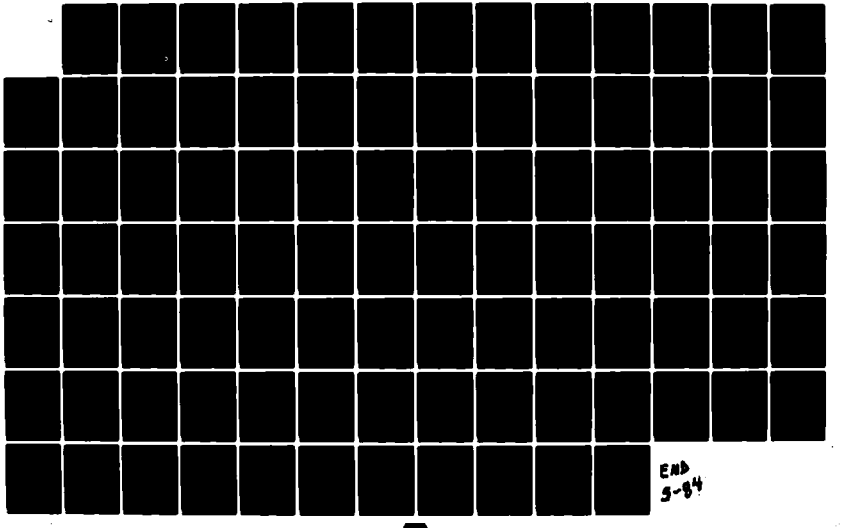

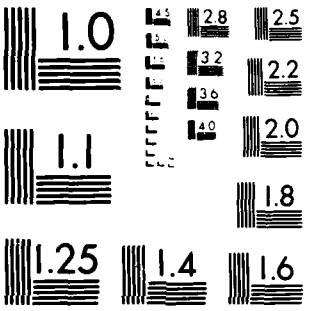

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PIT AND FISSURE SEALANTS IN YOUNG ADULTS: AN EVALUATION OF PLACEMENT TIME AND RETENTION RATE USING TWO ISOLATION TECHNIQUES

by

Bruce Allan Matis

Submitted to the Faculty of the Graduate School in partial fulfillment of the requirements for the degree of Master of Science in Dentistry, Indiana University School of Dentistry, 1983.

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INTRODUCTION

Most current textbooks state that pit and fissure sealant use should be an integral part of primary prevention, especially in children, because they offer specific protection against the occurrence and progression of a specific disease, namely dental caries. The American Dental Association endorses the use of sealants as a proven effective preventive measure which will contribute to the prevention of occlusal caries (1).

Recent statewide and national caries prevalence studies in children and young adults indicate that pit and fissure caries accounts for 87.5% and 83%, respectively, of the total caries experience (2, 3). Drastic reductions in the DMFS are possible by elimination of anatomically defective areas with sealants. Therefore, a new initiative is necessary in dentistry to further decrease the caries rate which has already been significantly reduced for proximal caries during the past 20 years.

Yet many unanswered questions remain concerning the use of sealants. Only 15% of dental practitioners report that they routinely use them (4). In the dental profession, controversy exists as to their need and effectiveness in young adults (5, 6). Another lingering question which has not been resolved is whether the extra time necessary for rubber dam placement, compared to cotton

roll isolation, translates into a signficant increase in sealant retention (7, 8).

This study represents an attempt to answer two questions -- whether sealants can be retained effectively in young adults and which of two methods of isolation is more practicable from a time and retention standpoint. These questions are very germane, as both the United States Air Force and Army Dental Services are currently placing sealants in children, but question their efficacy in young adults. For most of the 80,000 new recruits who enter the Air Force each year, it will be the first time they have lived away from home for an extended period and had a steady income. Under these circumstances, their diet may become cariogenic due to military-induced stress, lack of parental supervision and the ability to determine one's own diet. Hopefully, at the end of four years, when most of these recruits leave the military service, their caries rate will have declined due to the cultivation of proper oral hygiene and to the more mature outlook that comes with experience and training. Sealants may help carry these young military adults over this highly caries-prone part of their lives until they learn to control their dental diseases.

REVIEW OF THE LITERATURE

Prevalence of occlusal caries

In 1778 Hunter recognized the necessity of restoring the anatomically defective areas on the occlusal surfaces of teeth (9). He stated:

> ...stopping up the cavity becomes, in many cases, the means of preventing future attacks of the inflammation, and often retards even the progress of the disease, that is, the farther decay of the tooth, so that many people go on for years thus assisted; but it is a method which must be put in practice early....

In 1835 Robertson (10) reported that decay seldom occurred on smooth clean surfaces. He noted that areas which retained food and debris became carious and concluded that the caries potential of a tooth was directly related to the form and depth of the pits and fissures in the tooth.

As early as 1890, G. V. Black (11) reported that 43-45% of all carious surfaces in the permanent dentition were located on the "grinding" surfaces. Likewise, Day and Sedwick (12) pointed out in 1925 that occlusal surfaces were responsible for 45% of the decay in 13-year-olds, yet represented only 12.5% of all available tooth surfaces. The narrow isolated crevices and grooves which harbor food and microorganisms were described as "the single most important anatomical feature leading to the development of occlusal caries" (13).

Recent state and national surveys have shown a high rate of DMFS on occlusal, lingual and facial pit and fissure surfaces and a low rate of DMFS on interproximal smooth surfaces. In a 1982 statewide survey in Indiana (2), pit and fissure DMFS for persons in the 6-to-20-year age group accounted for 87% of the total DMFS rate. Nationally, pit and fissure DMFS for the 5-17 year age group in a 1980 survey (3) accounted for 83% of the total DMFS rate. Caries prevalence occurred at a fairly constant rate. Occlusal caries did not necessarily occur within 6 months following eruption; therefore, sealant use could be effective if placed on "at risk" occlusal surfaces. In a 1982 study, Walter reported that 90 percent of the lesions in naval recruits affect the occlusal surfaces (14).

Previous attempts at reducing occlusal caries by means other than sealants

Various methods have been advocated to control caries in occlusal pits and fissures. In 1905 W. D. Miller reported that under *in vitro* conditions, silver nitrate was effective in decreasing enamel solubility (15). In 1942 Klein and Knudsen conducted *in vivo* experiments using silver nitrate and found no difference in caries rates between treated and untreated molars in the permanent dentition of children (16).

In 1923 Hyatt proposed a technique he called prophylactic odontotomy (17). It consisted of obliterating the occlusal and facial pits and fissures by mechanical preparation of the teeth. The cavity preparations were filled with amalgam. The aim of this technique was to make a more conservative restoration than would otherwise be possible. In 1926 Bodecker proposed the principle of fissure eradication (18). This consisted of widening the fissures mechanically, thus making them nonretentive to food particles or bacteria. The techniques of both Hyatt and Bodecker required the removal of vital, non-carious tooth structure.

In 1945 the presence of fluoride in the water supply was identified as the agent contributing to a dramatically decreased caries incidence, especially in certain geographical areas of the United States. In the early 1950s, fluoride was first added to the water supply in many of the larger cities and reduced the overall incidence of dental caries by about 60%.

In 1958 Averill et al.(19) reported that a group of children living in a fluoridated area had as many occlusal surfaces affected by caries at the age of 10 as children living in non-fluoridated area had at the age of eight. After five years of fluoridation, an average two-year delay in the appearance of caries was observed on all four occlusal surfaces of permanent molars.

In 1978 Backer-Dirks et al.(20) reported that adding 1 ppm of fluoride to the water supply reduced occlusal caries by approximately 36%, compared to 75% for proximal lesions and 86% for gingival lesions. He wrote:

> The protective effect of water fluoridation is not uniform throughout the mouth. The least susceptible anterior teeth are likely to remain completely caries free. Pit and fissure areas on the biting surfaces of the posterior teeth receive about 30 to 40 percent protection, whereas the interproximal and gingival surfaces of the teeth show much higher levels of benefit.

Sealants: The Material

Buonocore is credited as making the first attempt to bond materials into anatomically defective areas (21). In 1955 he reported that a self-curing methyl methacrylate resin could be bonded to the occlusal surfaces of a tooth if the enamel was pre-etched with 85% phosphoric acid for 30 seconds.

The physical properties of sealant materials have continued to improve, but the concept of acid etching represented a major breakthrough for dental researchers and clinicians. It enabled materials to be mechanically bonded onto the enamel surfaces to seal out cariogenic substrate and microorganisms. In 1966 Takeuchi used alkylcyanoacrylate with

a methyl methacrylate polymer to seal teeth (22). In the following year Ceuto and Buonocore reported using a clear liquid methyl-2-cyanoacrylate monomer and a powder filler of silicious ingredients to seal teeth (23). Neither of these materials was marketed due to problems related to handling characteristics. A rapid decomposition of the material occurred in the presence of moisture, and the biodegradation of cyanoacrylates was discovered to release formaldehyde into the oral fluids (24).

In 1965, the classic work of Bowen resulted in the formulation of what is commonly known today as the Bis-GMA resin system (25). This is the chemical reaction product of bisphenol-A and glycidyl methacrylate. Bis-GMA is used in all of the sealant systems currently approved by the American Dental Association (Table I) (26).

Selected properties of sealants

Polymerization

Three types of sealant polymerizing systems are available for activating Bis-GMA resin: ultraviolet light, visible light, and chemical. In the ultraviolet light curing system, benzoin methyl ether or higher alkyl benzoin ethers

activate the peroxide curing system. In the visible light curing system, diketones and aromatic ketones are used in conjunction with the reducing agents, such as tertiary amines, for polymerization activation. Chemical activation (polymerization) occurs when one component containing the benzoylperoxide initiator and the other containing the tertiary amine activator or accelerator are mixed (27).

Unfilled vs. filled

The relative wear of the unfilled and filled sealants in vivo is similar, according to a study by Jensen and co-workers (28). However, since each patient had both sealant types applied to the same tooth type in the contralateral quadrant, one sealant may have affected the wear of the other sealant. Raadal (29) in an in vitro study concluded "even a small amount of filler acts as an effective barrier to wear." St. Germain (30) has reported that a higher percentage of filler in experimental microfil composites does not necessarily contribute to increased wear resistance in vitro.

Colored vs. transparent sealants

Three of the six ADA approved sealants are colored. Concise Brand White Sealant contains 2% titanium dioxide, which

colors it white; Delton (tinted) has 0.07% annatto, which produces an amber yellow shade; and Oralin Pit and Fissure Sealant has the fluorescent dye, 0.01-0.001% rhodomine B, which makes it bright pink (31). The three transparent ADA approved sealants are Delton, Nuva-Seal P. A. and Nuva-Cote (Table I).

Dentists sometimes perceive that patients will object to colored sealants, and therefore they list this trait as a disadvantage. However, clinicians who regularly use colored sealants state that they receive few, if any, complaints from children or their parents (32, 33). In fact, colored sealants have several major advantages. Since patients and parents can often examine the sealants which are in place, they can identify the need for replacements if they are lost. Parents can also see what they are paying for. Dentists and auxiliaries are able to view the extent of sealant coverage and if sealant inadvertently flows onto soft tissues or into the interproximal area, it can be observed and expeditiously removed. If gross sealant removal later becomes necessary (for example, during the treatment of interproximal caries), it can be accomplished with less iatrogenic tooth loss. Colored sealants can also be photographed to document their existence and retention.

Clinical sealant studies

Complete retention and caries reduction

When sealants are completely retained, occlusal cavities are prevented (34). Most of the reported long-term studies deal with a single application of sealant. When these studies are compared, it is imperative to note the following variables: 1) whether the teeth studied are deciduous or permanent, 2) the type of tooth sealed, 3) the sealant used, 4) the number of paired teeth studied, 5) the duration of study, 6) whether complete retention of sealants occurred, and 7) the percentage of caries reduction. No correlation has been found between the types of food eaten or the oral hygiene habits of patients and the retention of sealants (35). Table II compares reported sealant studies of at least three years duration (32, 33, 36-49) using the above seven criteria.

Isolation variations

None of the studies reported in Table II used rubber dam isolation. In 1979 Poulsen and Peltoniemi compared rubber dam and cotton roll isolation in a six-month study of the retention of sealants on deciduous teeth in 43 children 3-5 years old (50). One caries-free deciduous second molar was

sealed while working with rubber dam isolation, and its contralateral caries-free deciduous second molar was sealed while working with cotton roll isolation. Complete retention of sealants after six months was 65% and 69%, respectively, using rubber dam or cotton roll isolation. These differences were not statistically significant.

In 1981 a graduate student from the University of Michigan (7) evaluated clinical variables in the application of fissure sealants and concluded:

> 1. Sealants placed on mandibular teeth exhibited better quality and higher retention rates when applied under rubber dam isolation.
>
> 2. Sealants placed on maxillary molars demonstrated no significant difference in quality and retention when they were inserted by using either rubber dam or cotton roll isolation.
>
> 3. At six months, marginal integrity was significantly better for sealants placed utilizing rubber dam isolation.
>
> 4. There was 100% total sealant retention for sealants placed utilizing rubber dam isolation when the rubber dam was able to totally isolate the tooth from saliva.

Placement time of sealants

In 1981 Dennison and Straffon (8) compared the placement time for inserting an occlusal sealant using cotton

roll isolation and the placement time of an occlusal amalgam restoration using rubber dam isolation in contralateral teeth. Fifty-five pairs of teeth were studied in a group of 26 children between the ages of 6 and 9. The mean time for sealant application was 6 minutes, 29 seconds and the mean time for amalgam placement was 13 minutes, 51 seconds. Charbeneau et al.(52) reported "an average 8 minutes was used for the sealant application per quadrant."

Etchant variations

All of the ADA-approved sealant manufacturers recommend a 60 second etch time. Stephen et al.(53) compared the etch time for sealant placement of 60 and 20 seconds in contralateral first permanent molars of children 6-8 years old. After two years there was 100% complete retention on 20-second etched sites and 94% complete retention on 60-second etched sites on 102 occlusal surfaces. Not only is etching time an important factor, but Williams and von Fraunhofer (54) also called attention to the influence of washing time on the bond strength of fissure sealants applied to enamel:

> Whilst the best adhesion appear to be obtained with a 60 second etch/10 second wash time, valuable chairside time would be saved without significant loss of adhesion by adopting a 20 second etch/20 second wash procedure.

Study on Young Adults

In any special population group where a high occlusal caries attack rate exists with a concurrent low proximal caries attack rate, sealant use would be highly advisable. Sealant retention has been extensively studied in children, but only one study has attempted to determine whether mature enamel affects sealant retention in young adults. In 1976 Eden examined retention in 119 young adults ages 17 to 23 (55). During the study, the use of clear Nuva-Seal was discontinued in favor of the same material containing a red dye for better visualization. Unfortunately, the red dye apparently inhibited ultraviolet light penetration which subsequently affected polymerization of the sealants. This resulted in a very significant decrease in complete retention values for tinted sealants at 24 months of 24.8% as compared to an 86.1% retention rate for clear sealants during the same time period. The complete sealant loss at 24 months was 2.8% for the clear sealants vs. 46.7% for those that were tinted.

In a 1980 study of occlusal surface pit and fissure caries in 450 naval recruits, Wirthlin and co-workers (5) reported a high caries attack rate for the first six months of service. During this period, the molars had an average caries

attack rate of 20.0%, compared to the premolar rate of 3.1%. Half of the new navy recruits developed one or more occlusal carious lesions during the first six months of active duty.

METHODS AND MATERIALS

Identification and Selection of Subjects

Twenty-seven freshman dental students at Indiana University participated in the study (Appendix 1). Twenty-two were males with a mean age of 23 years, 3 months and five were females with a mean age of 25 years, 7 months (Table III). They were recruited at one of three preventive dentistry personal oral hygiene clinics given early in the fall semester. A 10 minute explanatory lecture was presented by the investigator concerning the proposed study. Each interested dental student was approached individually as to his or her willingness to participate in the study. This was followed by a screening examination to ascertain if the subjects had contralateral caries-free and restoration-free molars.

Dental students were used because:

1. They were learning the importance of personal oral hygiene and preventive dentistry at the time of their recruitment and were willing to participate in the study.

2. Bitewing radiographs, and medical history forms were usually already in their dental treatment folders.

3. They were easily accessible for rapid follow-up.

4. Participation in the study would require modest time outlay: One

45-minute sealant placement appointment, and three 15-minute follow-up appointments were needed.

The half mouth design was used in which contralateral teeth were sealed. This design, used by Buonocore (56) and Horowitz et al.(57), minimizes variation due to oral environment, mechanical stress and other undefined sources of experimental error. The study included only first or second molars since these teeth were identified by Ripa (34) as having the highest loss rate of sealants.

The screening appointment was conducted during the freshman student's Preventive Dentistry Clinic by the principal investigator. Students who were dentally eligible to join the study were asked to read the protocol and were given an explanation concerning the full scope of the project. They were asked to read and sign the consent form (Appendix II) before treatment was initiated. The appointment forms (Appendix III) were numbered sequentially. Computerized random chart assignments (Appendix IV) determined which side and teeth were to be treated first in each arch. Cotton roll isolation was used on the first tooth on the chart for the maxillary arch and rubber dam isolation on the first tooth for the mandibular arch. A total of 138 occlusal surfaces were treated on 69 pairs of occlusal surfaces.

Source and Description of Materials

Delton Pit and Fissure Sealant(a) was used. In clinical trials with molars, Delton has a higher complete retention rate than other sealants available on the market (38, 49). It is a chemically autopolymerizing unfilled Bis-GMA resin.

Placement Technique

Isolation

Cotton roll isolation of mandibular teeth was accomplished by placement of two 1-1/2 inch long cotton rolls on the lingual aspect of the teeth being treated and a single 1-1/2 inch long cotton roll on the buccal aspect. Cotton roll isolation of maxillary teeth was accomplished by placement of a single cotton roll on the buccal area approximating the root surface of the tooth/teeth to be treated.

Rubber dam isolation of the tooth/teeth to be treated was accomplished through placement of an appropriate clamp retainer on the most distally located tooth to be treated in the quadrant. A heavy body rubber dam was placed over the

---

(a). Johnson and Johnson Dental Products Co., East Windsor, N. J.

retaining clamp and flossed interproximally so that only the teeth to be sealed were exposed through the dam. A Young's frame was used to position the dam facially. No anesthesia was used during any procedure in this study.

Cleaning

Hydrogen peroxide (3%) cleaning agent was carried to the tooth with a saturated cotton pellet. A pointed midget bristle brush used in a slow speed handpiece cleaned the stain, pellicle, microorganisms, and other debris from the occlusal surfaces of the teeth being treated. A sharp #23 explorer tine was forcibly dragged through the occlusal pits, fissures and grooves to mechanically clean the enamel tooth surfacs as thoroughly as possible. The occlusal tooth surface was saturated a second time with hydrogen peroxide solution and the pointed bristle brush cleaned the tooth further. Pumice slurry was not used to clean the occlusal surfaces because of the difficulty of ensuring its complete removal during washing (58).

Washing and Drying

The tooth was flooded with a strong spray of water for 10 seconds, followed by an air/water spray for 20 seconds.

Air was used to dry the tooth for 10 seconds while the assistant suctioned water and loosened debris with a high velocity suction apparatus. The cotton rolls were carefully changed on the lingual aspect of the mandible by placing a dry cotton roll on top of the moist one, then removing the inferior cotton roll with a cotton forceps. Then another dry one was placed on top of the first dry cotton roll and the inferior moist one was again removed. On the buccal aspect of the mandibular and maxillary arches, a single moist cotton roll was exchanged for a dry one.

Tooth conditioning

The occlusal surfaces of the tooth/teeth being treated were bathed for 60 seconds in the conditioning solution of 35% phosphoric acid provided by the manufacturer. In two patients where mild fluorosis was observed, the etching agent was allowed to remain on their teeth for 120 seconds. A stopwatch was used to time the procedure.

Washing and Drying

The acid etchant was removed from the occlusal surfaces of the tooth/teeth by flooding the tooth for 10

seconds with a steady stream of water, followed by an air/water spray for 20 seconds. Then the teeth were air dried for 30 seconds while the assistant used the high velocity suction to evacuate unwanted fluids or seepage. The cotton rolls were again changed using the aforementioned procedure. If a rubber dam isolation method was used, a 2 x 2 gauze sponge was placed distally to the bow of the retainer clamp after the conditioner was rinsed off, so that any fluid would be absorbed during the drying process.

After the drying process, the enamel areas to be sealed were visually inspected for a white and frosty appearance. Areas without such an appearance were re-etched for an additional 60 seconds, rewashed and redried.

Sealant placement

The assistant continued to dry the occlusal surface of the tooth with air while the dentist mixed the sealant for 15 seconds. The dentist used the sealant placing instrument to carry it to the site of the teeth. The tip of the instrument was touched on the distal slope of the mesial marginal ridge and the sealant was pulled through the occlusal groove and pits by capillary action. This minimized the entrapment of bubbles. Extreme care was used to avoid salivary contamination of the

etched surface/s. If such did occur, the etching and washing/drying process was repeated before sealing.

The low viscosity of the sealant and its high flow property made it difficult to contain the sealant on the occlusal surface of the maxillary molars due to gravity, unless the occlusal surface of the maxillary teeth was parallel with the floor of the room. The tooth/teeth in a maxillary quadrant usually required the placement of two separate increments of sealant so proper bulk could be obtained. The sealant was allowed to polymerize, undisturbed, for three minutes.

Occlusal adjustment

Articulating paper was used on all patients to insure that excess sealant was eliminated and arches were occluded in habitual centric. Because Delton Pit and Fissure Sealant is an unfilled Bis-GMA the completed sealant was left at a "very slightly high" stage. Unfilled sealants wear rapidly when abraded by an opposing tooth cusp. Each patient was told to return if any sensitivity was caused due to placement of the sealant. One patient returned after five days and stated he was still having temporomandibular joint dysfunction. When his teeth were articulated so that no premature sealant contact occurred in habitual centric, the symptoms ceased.

Methods for Obtaining and Recording Observations

Two stopwatches were used during the procedure. The first was activated by the assistant when the initial cotton roll or the rubber dam forceps was picked up. It was deactivated after the procedure had been accomplished and the cotton roll or rubber dam material had been removed from the mouth. The time was recorded on the Treatment Record form (Appendix II). Within five minutes, the alternate isolation technique was initiated on the opposite side. The treatment procedure was timed and recorded on the appointment form. All sealants were placed by one operator with the same assistant in the same dental treatment chair.

A second stopwatch was used to time four phases of the treatment: 60-second tooth conditioning, 10-second steady stream of water, 20-second water/air spray, and 15-second sealant mixing.

Two independent evaluators, M. L. and M. C., both experienced members of the faculty of the Graduate Operative Dentistry Department, examined each pit and fissure sealant at the recall periods to determine the status of sealant retention and the presence of irregularities at the sealant/enamel interface. This visual examination was completed using a mouth mirror, a sharp #23 explorer, compressed air and a dental unit mounted light source. To determine any differences in the two

isolation techniques, a set of criteria was established to measure the sealant/enamel interface irregularities. Both examiners were instructed in the criteria for evaluation. An *in vitro* model of 10 teeth containing sealants representative of each category was used to standardize the evaluators. The criteria used were as follows:

Category A

Retention without irregularities - required the intact sealant present to cover the pits and fissures and feather out in the grooves with no clinically detectable interruption of the surface of the sealant nor of the sealant/enamel interface.

Category B

Retention with irregularities - required a clinically detectable interruption of the sealant at the enamel interface.

Category C

Complete loss - required the total occlusal loss of the sealant.

The patient was instructed not to indicate, in any manner, to the examiners which isolation technique was used on either side. Only the patient's name and date appeared on the evaluation forms. Baseline and 7-month evaluation examinations were recorded on a different form (Appendix V) than was used on the 12-month evaluation (Appendix VI).

The 12 month evaluation form differed in that it subdivided category B into two divisions: 1) where no primary pits or fissures were exposed, and 2) where a primary pit or fissure was exposed.

On the 12 month evaluation form, category A and category B division 1 sealants defined complete retention. As long as the sealants protected the primary pits and fissures, they were considered as fulfilling their primary purpose. Category B, division 2 sealants defined partial retention, and category C sealants defined complete loss.

The examiners rated each sealed surface independently. A recorder was seated at both chairsides to record the examiner's observations. Two dental treatment chairs were used and the examiners exchanged positions, with the recorder remaining at the same chairside. Any discrepancies between examiners were noted by the recorders. Any disagreements were resolved before dismissal of the patient.

RESULTS

Placement time

In the mandible, the mean placement time using rubber dam was 8 minutes 43 seconds and the mean placement time using cotton rolls was 8 minutes 26 seconds (Table V). In the maxilla, the mean placement time using rubber dam was 9 minutes 57 seconds and the mean placement time using cotton rolls was 8 minutes 39 seconds (Table VI). The paired "t" test value for sealant placement time in the maxilla was p=4.53 which indicates a significance level of greater than 0.05. Sealant placement by means of cotton roll isolation was significantly more rapid than the rubber dam method of isolation in the maxillary arch only.

Sealant/enamel Interface Irregularities

Baseline examination

A single examiner using a sharp explorer examined 138 sealants in teeth for any sealant/enamel interface irregularity. Of the total, 135 sealants were initially placed in category A and three in category B. Two category B irregularities were present in teeth which had been isolated with cotton rolls and one in a tooth that had been isolated with rubber dam (Table VII). Two category B irregularities

occurred in the mandibular molars and one in the maxillary molar (Table VIII). This translates to an uncorrected chi square "p" significance value of 0.81 (Significance of 0.05 level is obtained with "p" value greater than 3.84.)

Seven-month examination

Two examiners evaluated all 138 surfaces for enamel/sealant interface irregularities. Examination by isolation technique (Table IX) placed 47 of 69 surfaces isolated with a rubber dam and 46 of 69 surfaces isolated with cotton rolls in category A, with the rest in category B. Examination of tooth surfaces by arch placed 31 of 50 mandibular molar surfaces and 62 of 88 maxillary molar surfaces in category A, with the rest in category B (Table X). This translates to a chi square "p" significance value of 1.03. Ninety-three sealants were reported as being in category A, 45 in category B, and none were in category C.

Twelve-month examination

Two examiners evaluated 136 sealants at 12 months for sealant/enamel interface irregularities. Examination by isolation technique (Table XI) placed 49 of 68 surfaces isolated with a rubber dam and 46 of 68 surfaces isolated with

cotton rolls in category A, with the rest in category B. Examination of tooth surfaces by arch placed 29 of 48 mandibular molar surfaces in category A and 66 of 88 maxillary molar surfaces in category A, with the rest in category B. This translates to a chi square "p" value of 3.13. Thus, 95 sealants were in category A, 41 were in category B and none were in category C (Table XII).

Sealant Retention - 12 Months

At 12 months, 65 of 68 sealants were completely retained using rubber dam isolation and 62 of 68 sealants were completely retained using cotton roll isolation. No sealants were completely lost (Table XIII). The examination for sealant retention by tooth surface indicated that the mandibular first molar had the lowest record of complete retention (80%). The mandibular second molar had 87% complete retention. The central pit of the maxillary first molar had 93% complete retention, and the central pit of the maxillary second molar had 97% complete retention. The two distal surfaces of both maxillary molars had 100% retention. A total of 127 of the 136 sealants evaluated (93%) were completely retained, 9 sealants, or 7%, were partially retained and none were completely missing (Table XIV). Of the teeth examined by arch, 41 of 48 sealants on the mandibular molars were completely retained and 86 of 88

sealants on the maxillary molars were completely retained. This translates to a chi square "p" corrected value of 5.62 (Table XV).

Interexaminer reliability.

Seven-month interface category data indicated that Examiner No. 1 placed 93 of 138 sealants in category A and Examiner No. 2 found 95 of 138 sealants in category A (Table XVI). They agreed 111 times and disagreed 27 times. Those disagreements, however, were all resolved at chairside.

Twelve-month interface category data indicated that Examiner No. 1 placed 101 of 136 sealants in category A and Examiner No. 2 placed 104 of 136 sealants in category A (Table XVII). They agreed 112 times and disagreed 24 times. Likewise, those disagreements were all resolved at the chairside.

The interexaminer reliability at 12 months indicated that Examiner No. 1 found 130 of 136 sealants completely retained, and Examiner No. 2 diagnosed 128 of 136 sealants as completely retained (Table XVIII). They agreed 132 times, and disagreed 4 times. Those disagreements were all resolved at the chairside.

TABLES

TABLE I

PHYSICAL PROPERTIES OF ADA FULLY ACCEPTED SEALANTS (26)

SEALANT	ACTIVATED	FILLED	COLORED
DELTON	CHEMICAL	NO	NO
DELTON (TINTED)	CHEMICAL	NO	YES
CONCISE BRAND WHITE SEALANT	CHEMICAL	NO	YES
ORALIN PIT & FISSURE SEALANT	CHEMICAL	NO	YES
NUVA-SEAL P. A.	ULTRAVIOLET	NO	NO
NUVA-COTE	ULTRAVIOLET	YES	NO

TABLE II

COMPLETE SEALANT RETENTION AND OCCLUSAL CARIES REDUCTION RATES
IN PERMANENT TEETH WITH SINGLE APPLICATION
RESULTS OF LATEST CLINICAL TRIAL OF OVER 3 YEARS IN LENGTH

STUDY	PERM TEETH USED	SEALANT USED	# TEETH (PAIRS) TREATED	MONTHS STUDY COVERS	% COMPLETE RETENTION	% CARIES REDUCTION
CONS (36)	1ST MOLAR	N. S.	1,176	36	33	41.5
FERREIRA (37)	PREMOLARS		*	36	62	*
	1&2 MOLARS	EPOXILITE 9075	*		32	*
MCCUNE ET AL. (38)	1ST MOLARS	DELTON	272	36	88	85
MEURMAN ET AL. (39)	1&2 MOLARS	N. S.	129	36	78**	88
ROCK & BRODNOCK (40)	1ST MOLARS	DELTON	125	36	41	36
	PREMOLARS					
	1&2 MOLARS	DELTON	89	36	77	33

TABLE II CONTINUED

Study	Perm Teeth Used	Sealant Used	# Teeth (Pairs) Treated	Months Study Covers	% Complete Retention	% Caries Reduction
Rock (41)	Premolars	AlphaSeal	117	36	82	73
	1&2 molars	AlphaSeal	44	36	30	65
Simonson (33)	Premolars					
	1&2 molars	Concise White	571	36	94	*
Tonn & Ruge (42)	1&2 molars					
	Premolars	Delton	106	36	88	***
		Epoxylite 9075	318		84	***
		N. S. PA	106		70	***
		Lee Seal	106		68	***
Shey & Houpt (43)	1st molars	Delton	81	45	68	68
Charbeneau (44)	1st molar	Kerr	97	48	52	54
Cline & Messer (45)	1&2 molars	N. S.	79	48	24	*
Going et al. (46)	Premolars	N. S.	141	48	64	60
	1&2 molars	N. S.	41	48	28	29

TABLE II CONTINUED

Study	Perm Teeth Used	Sealant Used	# Teeth (Pairs) Treated	Months Study Covers	% Complete Retention	% Caries Reduction
Leake & Martinello (47)	1st molars	N. S.	840	48	20	22
Gibson et al. (32)	1st molars	Oralin	266	60	68	51
Horowitz et al. (48)	Premolars 1&2 molars	N. S.	840	60	42	39
Mertz-Fairhurst et al. (49)	1st molars	N. S.	87	84	33	10
		Delton	80	84	64	56

Epoxylite 9075 is a polyurethane, AlphaSeal is a Urethane-Acrylate and the rest are Bis-GMA resins.

* Data not available

** Classification of "good retention" not complete retention

***Epoxylite 9075 used as control

TABLE III

SEX AND AGE DISTRIBUTION OF PATIENTS AT BASELINE

SEX	IN STUDY NO	%	AGE MIN	MEAN	MAX
FEMALE	5	18.5	21 Y 9 M	25 Y 7 M	27 Y 8 M
MALE	22	81.5	22 Y 0 M	23 Y 3 M	26 Y 1 M

TABLE IV

DISTRIBUTION OF TREATED SURFACES

FIRST MOLARS 38 OCCLUSAL SURFACES			SECOND MOLARS 100 OCCLUSAL SURFACES			
MAXILLARY		MANDIBULAR	MAXILLARY		MANDIBULAR	
CENTRAL	DISTAL		CENTRAL	DISTAL		TOTAL
14	14	10	30	30	40	138

TABLE V

PLACEMENT TIME OF SEALANTS IN THE MANDIBLE WITH DIFFERENT ISOLATION TECHNIQUES

	MEAN TIME	MINIMUM TIME	MAXIMUM TIME	NO. TEETH	NO. SURFACES
RD	8:43	7:07	12:06	25	25
CR	8:26	6:58	11:11	25	25

TABLE VI

PLACEMENT TIME OF SEALANTS IN THE MAXILLA WITH DIFFERENT ISOLATION TECHNIQUES

	MEAN TIME	MINIMUM TIME	MAXIMUM TIME	NO. TEETH	NO. SURFACES
RD	9:56	7:41	16:05	22	44
CR	8:39	5:57	15:28	22	44

TABLE VII

BASELINE SEALANT-ENAMEL INTERFACE
IRREGULARITY CATEGORY BY ISOLATION TECHNIQUE

	A	B	C	TOTAL
RUBBER DAM	68	1	0	69
COTTON ROLL	67	2	0	69
TOTAL	135	3	0	138

TABLE VIII

BASELINE SEALANT-ENAMEL INTERFACE
IRREGULARITY CATEGORY BY TOOTH SURFACE AND ARCH

MOLAR	A	B	C	TOTAL
MAND 1ST	10	0	0	10
MAND 2ND	38	2	0	40
MAX 1ST (D)	14	0	0	14
MAX 1ST (C)	14	0	0	14
MAX 2ND (D)	30	0	0	30
MAX 2ND (C)	29	1	0	30
TOTAL	135	3	0	138

TABLE IX

SEALANT-ENAMEL INTERFACE IRREGULARITY CATEGORY
BY ISOLATION TECHNIQUE AT SEVEN MONTHS

	A	B	C	TOTAL
RUBBER DAM	47	22	0	69
COTTON ROLL	46	23	0	69
TOTAL	93	45	0	138

TABLE X

SEALANT-ENAMEL INTERFACE IRREGULARITY CATEGORY
BY TOOTH SURFACE AND ARCH AT SEVEN MONTHS

MOLAR	A	B	C	TOTAL
MAND 1ST	7	3	0	10
MAND 2ND	24	16	0	40
MAX 1ST (D)	9	5	0	14
MAX 1ST (C)	12	2	0	14
MAX 2ND (D)	20	10	0	30
MAX 2ND (C)	21	9	0	30
TOTAL	93	45	0	138

TABLE XI

SEALANT-ENAMEL INTERFACE IRREGULARITY CATEGORY
BY ISOLATION TECHNIQUE AT TWELVE MONTHS

	A	B	C	TOTAL
RUBBER DAM	49	19	0	68
COTTON ROLL	46	22	0	68
TOTAL	95	41	0	136

TABLE XII

SEALANT-ENAMEL INTERFACE IRREGULARITY CATEGORY
BY TOOTH SURFACE AND ARCH AT TWELVE MONTHS

MOLAR	A	B	C	TOTAL
MAND 1ST	6	4	0	10
MAND 2ND	23	15	0	38
MAX 1ST (D)	11	3	0	14
MAX 1ST (C)	11	3	0	14
MAX 2ND (D)	23	7	0	30
MAX 2ND (C)	21	9	0	30
TOTAL	95	41	0	136

TABLE XIII

SEALANT RETENTION BY ISOLATION TECHNIQUE
AT TWELVE MONTHS

	CR	PR	CL	TOTAL
RUBBER DAM	65	3	0	68
COTTON ROLL	62	6	0	68
TOTAL	127	9	0	136

TABLE XIV

SEALANT RETENTION BY TOOTH SURFACE
AT TWELVE MONTHS

MOLAR	CR	%	PR	CL	TOTAL
MAND 1ST	8	80	2	0	10
MAND 2ND	33	81	5	0	38
MAX 1ST (D)	14	100	0	0	14
MAX 1ST (C)	13	93	1	0	14
MAX 2ND (D)	30	100	0	0	30
MAX 2ND (C)	29	97	1	0	30
TOTAL	127	93	9	0	136

TABLE XV

SEALANT RETENTION BY DENTAL ARCH AND METHOD OF ISOLATION AT TWELVE MONTHS

	CR	PR	CL	TOTAL
MAX ARCH				
RUBBER DAM	44	0	0	44
COTTON ROLL	42	2	0	44
TOTAL	86	2	0	88
MAND ARCH				
RUBBER DAM	21	3	0	24
COTTON ROLL	20	4	0	24
TOTAL	41	7	0	48

TABLE XVI

SEVEN-MONTH INTER-EXAMINER RELIABILITY DATA
ON SEALANT-ENAMEL INTERFACE IRREGULARITY CATEGORIES

	A	B	C	TOTAL
EXAMINER 1	93	45	0	138
EXAMINER 2	95	43	0	138

TABLE XVII

TWELVE-MONTH INTER-EXAMINER RELIABILITY DATA
ON SEALANT-ENAMEL INTERFACE IRREGULARITY CATEGORIES

	A	B	C	TOTAL
EXAMINER 1	101	35	0	136
EXAMINER 2	104	32	0	136

TABLE XVIII

TWELVE-MONTH INTER-EXAMINER RELIABILITY DATA ON SEALANT RETENTION

	CR	PL	CL	TOTAL
EXAMINER 1	130	6	0	136
EXAMINER 2	128	8	0	136

TABLE XIX

NUMBER OF DIFFERENT RESPONSES BY EXAMINERS WHICH WERE RESOLVED

SEALANT-ENAMEL INTERFACE IRREGULARITY		RETENTION
7 MONTH	12 MONTH	12 MONTH
27	20	4

DISCUSSION

Placement time

In this study, the mean placement time of sealants was 17 seconds faster with cotton roll isolation than with rubber dam isolation in the mandibular arch. This time difference was not significant using the paired "t" test. However, the mean placement time of sealants in the maxillary arch was significantly different using the two methods of isolation. In the maxillary arch it required a longer mean time of 1 minute 18 seconds for rubber dam isolation than for isolation by cotton rolls. The practical import of such a difference is questionable, however, since the rubber dam placement procedure can be delegated to the chairside dental assistant.

Dennison and Straffon (8) reported a mean time of 6 minutes 29 seconds for sealant application on permanent posterior teeth. Times for washing and drying of the non-fluoridated abrasive slurry cleaning agent were not reported. A 15-second rinse for the conditioning solution was used. No rubber dam isolation was used for the sealant phase of treatment. In the present study, the mean placement time was 8 minutes 32 seconds for sealant application on permanent

first and second molars using cotton roll isolation. A 10-second water and 20-second air/water spray procedure totaling 30 seconds occurred twice during the total procedure. If the difference in rinse times between the two studies was subtracted from the mean sealant placement time in the present study, a very similar time for sealant placement would result. The times in the present study are similar in length to those of Charbeneau et al. (52). They reported a placement time of 8 minutes per quadrant.

An etch time of 60 seconds is recommended by all manufacturers of sealants currently approved by the American Dental Association. A recent _in vivo_ study by Stephen et al. (53) reported improved retention using a shorter etch time of 20 seconds versus the standard 60 seconds. No improved bond strength of Bis-GMA resin to tooth _in vitro_ using a 30- or 60-second etch times with 37% phosphoric acid was obtained over the 15-second etch time by Roberts et al. (59). The depth of etch using various concentrations has been studied extensively (60, 62), but minimal attention has been given to acid etching times. Further studies should be accomplished to determine how short an etch time is required for optimal bond strength of sealants. A shorter etch time would be especially useful in the cotton roll isolation technique because of the difficulty in maintaining strict salivary isolation during etching.

Sealant/Enamel Interface Irregularity

In an attempt to determine the optimal isolation technique, a strict set of criteria was established. Sealants in category A had no clinically detectable ledges or irregularities between the sealant/enamel interface using a sharp #23 explorer. Any sealant/enamel interface irregularity or ledge was cause to place the sealant in category B. Category C was defined as the absence of clinically detectable sealant in the occlusal pits or fissures.

Through all three examination periods, the sealants placed with rubber dam isolation performed only slightly better clinically than those placed with cotton roll isolation. This is not surprising, since the protocol dictated a re-etching procedure if any contamination of the etched occlusal surface occurred during sealant placement.

When the category of sealant/enamel interface irregularity is considered by arch, the level of significance is approached at the 12-month recall with the maxillary and mandibular arches having a category A sealant rate of 75% and 60%, respectively.

Retention

Complete retention, which was 100% with both isolation techniques at baseline, dropped to a mean of 93% at 12 months. No sealants were completely lost at any recall appointment, and none were replaced during the 12-month study. Rubber dam isolation and cotton roll isolation exhibited 96% and 91% complete retention, respectively, at 12 months. These values do not approach clinical significance, indicating that retention rates are probably not related to isolation method, PROVIDED the insertion technique is carefully followed.

When one compares complete sealant retention at 12 months in the maxillary arch vs the mandibular arch, the data show significance at the 0.05 confidence level, with the maxillary arch having 98% complete retention and the mandibular arch 85%. Sealants in the maxillary arch have a decreased surface area due to the prominent transverse ridge which divides the central and distal grooves. The decreased size appears to contribute to higher retention rates.

Most sealant studies of over three years indicate that complete retention in the mandibular molars is more common than in the maxillary molars (39, 44, 48, 49). However, none of these studies reporting sealant retention between the arches have been performed on young adults in whom access to the sealant working area is usually better than in children.

Interexaminer Reliability

It is difficult to identify sealants without completely drying the occlusal surfaces of the molars. Due to the transparent property of the sealant, careful clinical evaluation with a sharp #23 explorer was required. It was therefore not surprising that 20% of cases in the category of sealant/enamel interface irregularities at the 7-month recall had to be resolved at chairside due to the difficulty of identifying the transparent sealants. At 12 months the rate of identifications needing to be resolved at chairside was 15%. At 12 months the rate was 3% (Table XIX).

Sealant Use

On the basis of this study, the use of sealants on non-restored molars is recommended when a special adult population group has been identified as having an overall occlusal decay rate of 1.0 surface per year or greater, regardless of their age, sex, or race. If caries primarily occurs in the interproximal areas, use of sealants is not indicated.

Sealant use on any occlusal surface should be recommended when a diagnosis of an incipient occlusal lesion is recorded. Sealants which are completely retained with the

margins sealed will inhibit caries formation (34). Reversal of an active carious lesion to an inactive state or even a remineralized state may occur (63, 64). If sealants come off, any tags remaining will offer partial protection from the carious process (65, 66).

SUMMARY AND CONCLUSIONS

Placement time using occlusal pit and fissure sealants in the mandibular tooth/teeth did not vary significantly with either isolation technique.

Placement time of sealants in the maxillary tooth/teeth was significantly less ($p<0.05\%$) with the cotton roll method of isolation than the rubber dam method.

Sealants placed with rubber dam isolation had fewer sealant/enamel interface irregularities at each examination period than those placed using cotton rolls. Although the difference increased over the period of the study, the differences were not significant at 12 months.

The sealants placed in the maxillary arch were more retentive at the 0.05% level of significance than those placed in the mandibular arch.

The interexaminer evaluations were similar but due to the transparent nature of the sealant being studied, there were many interexaminer differences in categories which had to be resolved at chairside.

Complete retention of occlusal pit and fissure sealants at 12 months in young adults was 93%. No sealants were completely lost.

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APPENDIX

APPENDIX I

Participants in the Study

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APPENDIX II

CONSENT FORM

NAME: _____ BIRTHDATE: _____

ADDRESS: _____ TELEPHONE: _____

ZIP CODE: _____

The purpose of the study entitled "Retention and Placement Time of Pit and Fissure Sealants Inserted with Different Isolation Techniques on Young Adults," has been explained to me and I have read a copy of the protocol. The purpose of this study is to investigate the length of time that a sealant will stay on a tooth, using two different ways of isolating teeth to keep them dry. The tooth surface to be treated must remain dry until after the sealant has been placed. One way to isolate the tooth is with cotton rolls, and the other way to isolate it is with a rubber dam. Both ways of isolating teeth are being used by practicing dentists. Both methods will be tried on me, and photographs taken of the treated arch/arches, if I consent to being a patient in this study.

Once the dentist has placed the pit and fissure sealants in my mouth, I will be given an appointment to return in six (6) months to have an independent evaluator examine the teeth and take photographs of the arch/arches that have been sealed. This will continue every six (6) months for three (3) years. The examinations will last no more than fifteen (15) minutes. There will be no charge involved with any of the treatment or examining phases of this study. While a participant in this study I will be able to have any of the pit and fissure sealants which are partially or totally lost replaced free of charge. There is no hidden risk in this study. Participation is voluntary and I have been told that participation, lack of participation, or dropping out of the study prematurely will not affect my academic standing in anyway, or jeopardize the quality of dental care that I receive at Indiana University School of Dentistry. I will not hold the School of Dentistry responsible for any additional treatment that I may be in need of at the present time.

When the results are published, my name will be kept in confidence. I understand that if I have any questions regarding materials, or procedures to be used, I can ask them now or at any time during the study.

The statements above have been explained to my understanding.

_____ _____

DATE PARTICIPANTS SIGNATURE

_____ _____

WITNESS ADMINISTRATOR'S SIGNATURE

_____

To be filled in by examining dentist at screening appointment.

Eligible contralateral pairs of teeth (circle)

Maxillary arch: 2,15 (central) 2,15 (distal) 3,14 (central) 3,14 (distal)

Mandibular arch: 18,31 19,30

FORM # _____

APPENDIX III

NAME: _____ DATE: _____

TREATMENT RECORD:

Check Items Accomplished:

____ Rubber dam placement/Cotton roll isolation

____ Bristle brush prophy and wash

____ Etch

____ Wash

____ Cotton roll change

____ Sealant placed on tooth/teeth # ____, # ____, # ____, # ____

____ Floss contacts

____ Check occlusion

Total Treatment Time: _____ Minutes _____ Seconds

DENTISTS OBSERVATIONS:

APPENDIX IV

PATIENT ASSIGNMENT SHEET

		Maxilla				Mandible			
NAME	DATE	15	14	2	3	30	31	18	19
NAME	DATE	2	3	15	14	19	18	30	31
NAME	DATE	3	2	14	15	30	19	31	18
NAME	DATE	15	14	3	2	19	31	30	18
NAME	DATE	15	14	3	2	30	19	31	18
NAME	DATE	14	15	3	2	18	31	19	30
NAME	DATE	14	15	2	3	18	30	19	31
NAME	DATE	3	2	14	15	19	31	30	18
NAME	DATE	2	3	15	14	19	18	30	31
NAME	DATE	15	2	3	14	18	19	30	31
NAME	DATE	3	2	15	14	18	31	19	30
NAME	DATE	2	3	14	15	31	18	19	30
NAME	DATE	14	3	15	2	31	18	30	19
NAME	DATE	15	14	2	3	30	31	18	19

APPENDIX V

NAME: _____ DATE: _____

CONTRALATERAL TEETH SEALED: _____ _____ _____ _____

	TEETH NUMBERS	
	_____	_____
Sealant completely retained	____	____
Sealant partially retained	____	____
* Sealant completely lost	____	____
	_____	_____
Sealant completely retained	____	____
Sealant partially retained	____	____
* Sealant completely lost	____	____
	_____	_____
Sealant completely retained	____	____
Sealant partially retained	____	____
* Sealant completely lost	____	____
	_____	_____
Sealant completely retained	____	____
Sealant partially retained	____	____
* Sealant completely lost	____	____

* Sealant replaced due to complete loss.

APPENDIX VI

NAME:_____ DATE:_____

CONTRALATERAL TEETH SEALED:_____ _____ _____ _____

	TEETH NUMBERS	
	_____	_____
Sealant completely retained	_____	_____
Sealant partially retained (No primary pits or fissures exposed)	_____	_____
Sealant partially retained (Primary pits or fissures exposed)	_____	_____
* Sealant completely lost	_____	_____
Operative treatment rendered	_____	_____
I like this sealant best	_____	_____
	_____	_____
Sealant completely retained	_____	_____
Sealant partially retained (No primary pits or fissures exposed)	_____	_____
Sealant partially retained (Primary pits or fissures exposed)	_____	_____
* Sealant completely lost	_____	_____
Operative treatment rendered	_____	_____
I like this sealant best	_____	_____
	_____	_____

* Sealant replaced due to complete loss.

CURRICULUM VITAE

Bruce Allan Matis

February 26, 1943	Born in Blue Island Illinois
June 1967	B.S., Brigham Young University, Provo, Utah
August 4, 1967	Married Joan Thompson
June 1971	D.D.S. Case Western Reserve University, School of Dentistry Cleveland, Ohio
June 1971-September 1973	General Dental Officer Hill Air Force Base Ogden, Utah
October 1973-October 1974	Base Dental Surgeon Kwang Ju Air Force Base Kwang Ju, Korea
October 1974-September 1978	General Dental Officer Davis-Monthan Air Force Base Tucson, Arizona
September 1978-June 1980	Assistant Chief, Clinical Dentistry USAF School of Aerospace Medicine Brooks Air Force Base San Antonio, Texas
June 1980-August 1981	Chief, Dental Consultation USAF School of Aerospce Medicine Brooks Air Force Base San Antonio, Texas
August 1981-August 1983	MSD Operative Dentistry Indiana University School of Dentistry Indianapolis, Indiana

August 1983

Graduate Student
Oral Health Research Institute
Indiana University School
of Dentistry
Indianapolis, Indiana

Professional Organizations

American Dental Association
American Academy of Gold Foil Operators
Academy of Operative Dentistry
International Association for Dental Research
Association of Military Surgeons of the United States
American Academy of the History of Dentistry

ABSTRACT

Pit And Fissure Sealants In Young Adults: An Evaluation Of Placement Time And Retention Rate Using Two Isolation Techniques

by

Bruce A. Matis

Indiana University School of Dentistry
Indianapolis, Indiana

Sixty-nine pairs of contralateral first and second molar surfaces of young adults were sealed with Delton Pit and Fissure Sealant. Cotton roll or rubber dam isolation was determined by computer randomization on each pair. Placement time from the beginning to the end of the procedure and retention rate for 6 and 12 months are reported.

The occlusal surfaces were isolated, cleaned with 3% hydrogen peroxide, washed and dried. The occlusal enamel was then conditioned for 60 seconds with 35% phosphoric acid, washed and dried. The sealant was placed and its surface adjusted to eliminate premature occlusal contact.

Two experienced evaluators rated each sealed surface independently at baseline, and at 6 and 12 months. Any disagreements were resolved before dismissal of the patient.

Sealant placement by means of cotton roll isolation was significantly faster in the maxillary arch. However, the sealants placed using rubber dam isolation had fewer sealant/enamel interface irregularities.

Sealants placed in the maxillary arch were significantly more retentive than sealants in the mandibular arch. None of the sealants exhibited complete loss. The complete retention of occlusal pit and fissure sealants with both isolation techniques at 12 months was 93%.